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AUTHOR	Peled, Ofra N.; Kim, Anna C.
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ABSTRACT

This paper offers a new method of evaluating the Supplemental Instruction (SI) model as implemented in biology courses at National-Louis University in Chicago, Illinois. From 1990 through 1993, 14 classes of general biology were taught by the same instructor, using the same textbook and syllabus. An SI leader was available for five of the classes, and conducted SI sessions before or after class. A total of 140 students attended classes without SI, while 94 students with an SI leader. It was found that classes with SI had an average grade of 74.1 percent, while those without SI had an average grade of 67.6 percent. Within the classes that had an SI leader, grades of students who attended SI sessions were, on average, 12 percent higher than the grades of students who did not attend the sessions. (Contains 11 references.) (MDM)

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EVALUATION OF SUPPLEMENTAL INSTRUCTION AT THE COLLEGE LEVEL

Ofra N. Peled

Science Department
National-Louis University
18 S. Michigan Ave.
Chicago, IL 60603
Tel: (312) 621-9650 ext. 3409
Fax: (312) 621-1205

and

Anna C. Kim

Center for Academic Development
National-Louis University
2840 Sheridan Rd.
Evanston, IL 60201
Tel: (847) 256-5150 ext. 2357
Fax: (847) 256-1057

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Abstract

Supplemental Instruction (SI) is a model of academic support that has been used effectively at the college level to promote higher-level thinking skills in an interactive setting. We analyze this model as used for a high-risk biology course on a multicultural, multiethnic university campus. Examination grades indicated that the average grade of participants in classes that had SI sessions was significantly higher than that of participants in classes where SI sessions were not offered. Assessing the effect of SI in this way avoids the bias of comparing students of the same class who attend SI sessions with students who do not attend.

Introduction

In this paper we describe a new method of evaluating the Supplemental Instruction (SI) model as implemented in biology courses in an urban multicultural university campus. Classes with and without SI leaders were compared, instead of final grades of students who did or did not participate in SI sessions.

Supplemental Instruction is an integrative model of student academic support that was developed and tested during the mid 1970's at the University of Missouri (Blanc, DeBuhr, and Martin, 1983), and implemented at 150 institutions of higher education (National Center for Supplemental Instruction [NCSI], 1994). It is a process-product paradigm that determines its success on the final grades of students who attend or do not attend the SI sessions.

Garland (1987) conducted a study of students at 13 institutions to test whether SI was effective for minority students at both ends of the academic spectrum. The study reports that students in the SI group benefitted across all grade levels at a significance of 0.0001. For example, SI students in the lowest quartile and the highest quartile scored about 0.5 letter grade higher than non-SI students in the same quartile. In addition, the rate of D, F, and Withdrawals among SI students dropped 7%. Blanc, DeBuhr, and Martin (1983) report similar results regarding the effectiveness of SI for students of different levels of academic preparedness by analyzing the performance of students in seven courses who scored in the top and bottom quartiles of college entrance tests. Approximately 30% of students in both the top and the bottom quartiles participated in the sessions. Students participating in SI scored about 0.8 grades higher in both the top and the bottom quartiles than ones not participating. It also appeared that SI was associated with reduced D, F and W (withdrawal) grades, increased re-

enrollment and higher GPA. Kallison and Kenney (1992) compared the grades earned by students in a calculus course. Students who attended SI sessions earned between 0.1 and 0.4 letter grades higher than students who attended conventional tutorials. The same study reports that lower-ability students benefitted from SI more than higher-ability students.

The use of the SI model of academic support has been recently reported to attract minority students to medicine (Bridgham and Scarborough 1992), to benefit problem-solving in chemistry courses (Congos 1993), and to increase organizational skills and create learning strategies in biology (Matthews 1993).

The present study on the effect of SI in biology was conducted over the course of three years at National-Louis University (NLU), a private university with several campuses in the Chicago area, as well as throughout the US and overseas. The population at the urban campus, the site of this study, has a high percentage of minority students: approximately 20% are African-American, 10% Hispanic, and 6% Asian. This is about three times higher than minority percentages in Garland's (1987) study.

The coordinator of the SI program determined that General Biology and Introduction to Music were "high-risk" courses and eligible for the SI program, since fifty percent of the students were receiving grades of D or F, or W. Most students take General Biology to fulfill the science requirement of their programs. The course emphasizes the concepts of biology and serves as a prerequisite for all subsequent biological science courses.

At NLU the SI leaders are students who have successfully completed the course and are recommended by the instructor to the SI coordinator. Moreover, most of the SI leaders in Biology are students intending to major in elementary education. In their role as SI leaders,

they attend the lectures and laboratories and serve as role models for the currently enrolled students. The SI coordinator trains the leaders, making sure that the SI leaders' interactions with the students promote higher-level thinking skills rather than a repetition of the lecture.

The conventional method of assessing the success of the SI program is to compare the achievement of students who attended SI sessions with those who did not (Blanc, DeBuhr, and Martin, 1983; Lundeberg, 1990; Martin and Arendale, 1991; NCSI, 1994). However, despite the claims of the authors of the SI model (Blanc, DeBuhr, and Martin 1983), this type of comparison is liable to be grossly biased because the students are not randomly assigned to the SI or non-SI groups. Rather, they are self-selected, so it is very possible that the better students, who would have received the better grades in the first place, tend to be the ones who attend the sessions. Indeed, Visor, Johnson, and Cole (1992) reported that students who attended SI sessions regularly were the ones who possess high self-esteem, and found active participation in such sessions to be academically challenging.

In order to avoid this bias, we assess the success of the SI sessions by comparing the test scores of whole classes, some, but not all, of which had an SI leader. If SI participants are compared with non-participants within the same class, one cannot distinguish whether better performance is due to SI or rather to the difference in student characteristics. Our approach avoids this particular bias. We assume that the groups of students of different classes of the same course are equivalent and may therefore be compared. The SI leaders were available for only some of the Biology classes, choosing a class to work with based only on their own schedules.

Our approach of comparing whole classes does not permit direct inference as to which

students profit from SI. Not surprisingly, the influence of the SI sessions is affected by the degree of student attendance. Blanc, DeBuhr, and Martin (1983) reported a decrease in D, F and Withdrawal grades with the increase of participation in SI sessions. In our study, attendance at sessions was voluntary, so only some students attended the SI sessions, and those participating attended irregularly. We assume that the amount of participation in sessions increased the success of the class as a whole. It is, therefore, possible that with full attendance the effect of offering SI could have been even stronger than it appears from our data. We estimated what the full contribution of the SI would have been had all students participated fully.

We tested two hypotheses: 1) That the percent of very low grades was significantly decreased in classes with SI, and 2) that the average grade of the whole class increased in the classes with SI.

Materials and Methods

From the Winter of 1990 through the Winter of 1993, fourteen classes of General Biology were taught by the same instructor, using the same textbook and the same syllabus. An SI leader was available for five of those classes. Classes at NLU are typically small, approximately 20 students; a total of 94 students attended the classes where a leader was available, and 140 attended classes without one. The SI leader conducted sessions immediately before or after the class. The instructor sometimes assisted the leader with lecture notes, sample tests, and any other material that might help students master the content of the course. The names of students that attended and the number of sessions they attended were monitored by the leader, but the instructor was not informed, so as to prevent bias in

awarding final grades.

Students in each class took two midterms and a final exam. There were make-up tests available for the two midterms for students receiving less than 70%, with the higher grade establishing the final test grade. The final test grade was the unweighted average of the three test grades calculated in percentage points. The actual test grades are objective and comparable measures of knowledge because they are percentages of correct replies to a sample of questions out of the same pool. Final letter grades were not used in the present study because they also included points for the less objective laboratory reports, homework problems, and an oral report.

For purposes of this study, we assumed that any differences in the distribution of grades between classes with and without SI sessions were due solely to the availability of SI. We computed the respective class averages, and tested the significance of the difference by the Mann-Whitney U-test (Siegel, 1956). In addition, we calculated and plotted the distribution of grades. We compared the percentage of the low grades (below 60%) in SI classes to that in non-SI classes, and assessed the difference by a Chi-Square test. The same analysis was done for the high grades (above 80%).

For classes with an SI leader, we measured the attendance in SI sessions by means of an "SI Quotient," which is defined as the number of student-hours of attendance divided by the total number of student-hours offered (i.e., the total attendance in SI sessions divided by the product of the number of students in the class multiplied by the number of sessions offered).

Discussion of Results

The average grades of the 14 classes are shown in Table 1.

Table 1. Percentage grades of the classes (on a scale of 0-100 points)

	Day Classes	Evening Classes	All Classes
Non-SI classes (9 classes)	72.8, 55.3, 68.6, 77.6, 59.1, 68.5 Average = 67.0	68.5, 69.4, 68.3 Average = 68.7	67.6
SI classes (5 classes)	71.3, 79.3, 74.3, 76.4 Average = 75.3	69.4 Average = 69.4	74.1

There is considerable variability between the classes. Although it might be expected that day and evening students represent different student populations, there is no striking difference in the grades that the two groups earned. Therefore, results from the day and evening classes were pooled together to test the difference between the average grades in the SI and non-SI classes. The classes with an SI leader had an average grade of 74.1% and those without a leader had an average of 67.6%, a difference of 6.5 percentage points. (These are unweighted averages, since the units compared were whole classes). We tested the difference between the set of average grades of classes with and without an SI leader was tested by means of the Mann-Whitney U test and found it to be significant at a 0.05 confidence level.

As a comparison, we calculated the effect of SI according to the conventional method of measuring success in that program. Within the classes that had an SI leader, grades of students who attended SI sessions were on average 12.0% higher than grades of students who did not attend the sessions (the data leading to this difference are not shown). As stated above, we do not feel that this is an accurate measure of the effect of SI, since the students who attended the sessions were self-selected and not randomly assigned.

Table 2. Attendance in SI sessions

	Number of Students		Number of Sessions Offered	Total Attendance*	Avg. No. of Sessions Attended†	SIQ‡
	Attended	Not Attended				
Spring 91	7	6	No Data	No Data	No Data	
Fall 91	12	11	18	100	8.3	0.24
Winter 92	15	5	15	78	5.2	0.26
Spring 92	13	6	18	75	5.8	0.22
Winter 93	12	7	10	38	3.2	0.20

* The sum of the attendance counts for all sessions in quarter
† Average is the total attendance divided by the number of students who attended SI sessions
‡ SIQ is the SI quotient, the proportion of student-hours of attendance out of the total student-hours of available SI sessions

Table 2 shows the attendance in the SI sessions. For the four classes where SI quotients could be calculated, the quotients were 0.20, 0.22, 0.24, and 0.26. This reflects the fact that many students did not attend the sessions, and only a few attended sessions regularly. For instance, a quotient of 0.25 could have resulted if half of the students had ever attended a session, and those who did attend participated in only half of the sessions offered. If we pool together the four classes for which the SIQ could be computed, we find a total attendance of 291 student-hours out of $(12+11)\cdot 18 + (15+5)\cdot 15 + (13+6)\cdot 18 + (12+7)\cdot 10 = 1246$ student-hours of SI sessions available, yielding an average SIQ of $291 / 1246 = 0.23$. Presumably, if all students had attended all sessions, the improvement of the average grade would be more extensive than that observed. Most of the improvement would have been attained by full attendance of those students who had ever attended sessions, and a small part by the participation of those who had never attended sessions.

Assuming that the increase in the average grade is proportional to the SIQ, we estimate the increase to be 6.5 / 0.23 = 28.3 percentage points (average observed improvement divided by the average SIQ). This would raise the average grade from 67.6 to an "idealized grade" of 95.9 percentage points. Unfortunately, it is not feasible to test this proportionality assumption by performing regression analysis of the increase in grades versus SIQ on our data because (1) only 4 observations of SIQ are available and (2) they are too close (between 0.20 and 0.26) to permit a reliable fit. Thus, we regard the proportionality assumption to be merely a working hypothesis.

<FIGURE 1 SHOULD BE PLACED HERE.>

The distribution of grades in classes with and without an SI leader are shown in Figure 1. In classes that had an SI leader there were fewer students who earned low grades (below 60%), and more students who earned high grades (above 80%), compared to classes that had no SI leader. Chi-Square tests on our sample show that in both the high and low groups these differences are statistically significant at a 0.01 confidence level.

Significance of Results

The difference between grades of whole classes that had an SI leader and those that did not is 6.5 percentage points. If we compare the average grades of students who attended

SI sessions with those of students who did not within the same class, we find a larger difference of 12 percentage points. This 12% difference is about twice as much as the improvement of up to about one half letter grade found by Garland (1987) and NCSI (1994). However, percentage points and letter grades are not unequivocally comparable, as the former are more objective. The improvement of the grades of the students who actually attended the SI sessions cannot be completely attributed to the SI leader. Rather, many of these higher grades could be attributed to the interest, motivation, time devoted to studies, and other characteristics of this self-selected group of students who chose to attend the sessions.

Another way of assessing the effect of SI sessions on students' grades is to take into account the attendance in the SI sessions. Blanc, DeBuhr, and Martin (1983) showed that the percentage of failures and withdrawals decreases with the increase of percentage of attendance in SI sessions. To take into consideration the variation in the attendance we looked at the "SI quotient." We assumed as a working hypothesis that the contribution of the SI leader to improving the grades of the students is proportional to SIQ. Under this assumption and with full attendance of all students in all sessions (SIQ = 1), the average grade would have reached a surprising 95.9%. It is unrealistic to expect that any amount of academic support can increase grades to such an extent, since this estimate exaggerates the possibilities of improving grades by attending SI sessions. There may be several other factors involved, such as the time and effort students themselves invest to bring their grades up to the maximum.

In classes in which an SI leader was available, the number of students receiving

grades below 60% decreased, whereas the number of students receiving grades above 80% increased. This indicates that students can advance from the lower to the medium range of grades, and from the medium into the upper range. It also shows that even relatively good students attend SI sessions, and sheds an interesting light on who chooses to attend and who profits from the sessions. Students from all levels of academic potential attend and practically all benefit to some extent from attending SI sessions.

There are two limitations of our study. The first is the small number of classes, 14 in all. The second is the typically small class size (approximately 20 students); a greater class size would make the class average more reliable but would hinder the students. Therefore, whereas the results are statistically significant, one can question how much the results can be generalized. We believe that with larger lecture classes the effect of SI would be even more pronounced. In large classes there is less opportunity for individual attention by the instructor, and therefore the SI session has the potential of greater individual benefit.

Conclusion

Our approach to the assessment of the success of SI sessions avoids the bias of comparing self-selected groups. However, neither our approach of comparing the achievements of classes with and without an SI leader, nor the conventional method of comparing achievement of students who did or did not attend SI sessions, gives a full account of the potential of the SI model of academic support. Our approach reflects the effect of the leader, but certainly underestimates the maximum impact on individual students that may be gained from SI sessions, whereas the conventional approach exaggerates this impact. But both demonstrate considerably high success rates. In view of this conclusion,

students should be encouraged to attend in increasing numbers and more regularly.

Acknowledgement

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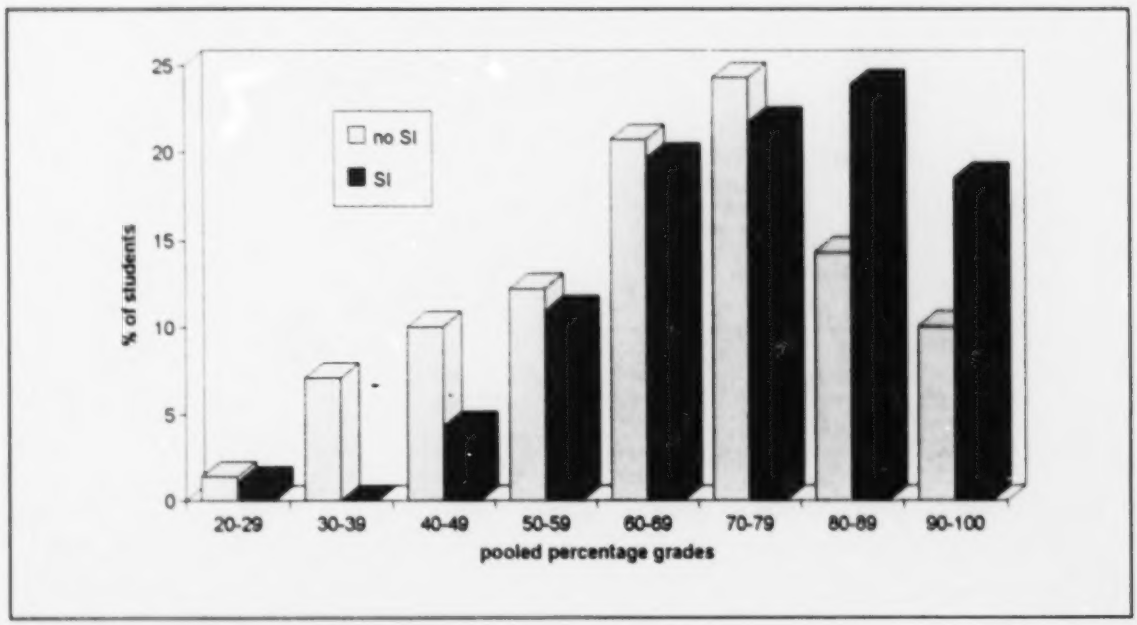

Figure 1. Grade distributions in classes with and without SI leaders

Table 1. Percentage grades of the classes (on a scale of 0-100 points)

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